

CLAIMS

What is claimed is:

1. A device for impelling one or more fluids through an exit conduit comprising:
a housing having a chamber for receiving and/or holding one or more fluids under pressure and an exterior surface, and said housing having at least a first exit opening, a first inlet opening, a second exit opening, and a second inlet opening, each opening extending from said chamber to said exterior surface for receiving conduit means;

a first exit conduit means received by said first exit opening in communication with said chamber for transporting fluids from said chamber out of said first exit opening, said first exit conduit means for connection with an analytical device;

a first inlet conduit means received by said first inlet opening in communication said chamber for transporting a first fluid into said chamber, said first inlet conduit means for connection to a first supply device;

a second inlet conduit means received by said second inlet opening in communication with said chamber for transporting a second fluid into said chamber, said second inlet means for connection with a second supply device;

a second exit conduit means received by said second exit opening in communication with said chamber for transporting fluids from said chamber out of said second exit opening, said second exit conduit means for connection with a waste receptacle; and

at least one valve means disposed in at least one of said first exit conduit means, said second exit conduit means and said second inlet conduit means, said valve means having a closed position wherein fluid is prevented from flowing through said valve means and an open position wherein said fluid is allowed to flow through said valve means, said valve means responsive to a signal to assume one of said positions;

wherein said chamber is for receiving fluid from each of said first inlet conduit means and said second inlet conduit means, and for discharging fluid through said first exit conduit means and said second exit conduit means.

2. The device of claim 1 wherein said at least one valve means is a freeze-thaw valve.
3. The device of claim 2 wherein said first fluid is a solute.
4. The device of claim 2 wherein said second fluid is a sample fluid.
5. The device of claim 1 further comprising a first exit conduit valve means interposed in said first exit conduit means.
6. The device of claim 5 wherein said first exit conduit means is a capillary having a first end in said first exit opening, a mid portion external to said housing, and a second end formed as a liquid chromatography column having an input end and an output end, wherein said first exit conduit valve means is disposed in said mid portion.
7. The device of claim 6 wherein said first end of said capillary extends into said chamber.
8. The device of claim 7 wherein a tip of said first end of said capillary is positioned in said chamber between said second inlet opening and said second exit opening.
9. The device of claim 6 wherein said capillary has an inner diameter between approximately 15 μ m and 150 μ m.
10. The device of claim 1 wherein each of said at least one valve means is operable with a pressure differential across said valve means of up to 120,000 psi.
11. The device of claim 1 further comprising a first supply device connected to said first inlet conduit means, said first supply device having a supply state wherein said first fluid is supplied at a pressure up to a maximum pressure and a stop state

wherein said first fluid is not supplied, said first supply device responsive to a supply signal to assume one of said states.

12. The device of claim 11 further comprising a control means for controlling each of said at least one valve means by sending a signal to said valve means to assume one of said open and closed positions.

13. The device of claim 12 further comprising a control means for controlling a first supply device by sending a supply signal to said supply device to assume one of said supply and stop states.

14. The device of claim 13 wherein said control means sends a supply signal to said first supply device to effect a supply state of the first supply device and sends one or more signals to said at least one valve means to effect a closed position of all conduit valve means for filling and pressurizing said chamber.

15. The device of claim 13 wherein said control means sends a supply signal to said first supply device to effect a stop state of said first supply device and sends one or more signals to said at least one valve means to effect a closed position of said first exit conduit valve means and an open position of said second inlet conduit valve means and said second exit conduit means for replacing a fluid in said chamber with said second fluid.

16. The device of claim 13 further comprising a fluid monitor for monitoring a fluid passing through said second exit conduit means for providing said control means with information about the composition of the fluid exiting said chamber.

17. The apparatus of claim 16 wherein said control means monitors said fluid at said second exit conduit for determining concentration.

18. The device of claim 13 wherein said control means sends a supply signal to said first supply device to effect a stop state of said first supply device and sends one or more signals to said at least one valve means to effect a closed position of said first

exit valve means and said second inlet valve means and an open position of said second exit valve means for discharging fluid from said chamber.

19. The device of claim 13 wherein said control means sends a supply signal to said first supply device to effect a supply state of said first supply device and sends one or more signals to said at least one valve means to effect a closed position of said second inlet valve means and said second exit valve means and an open position of said first exit valve means for impelling a pressurized fluid through said first exit conduit means.

20. The device of claim 11 wherein said first supply device is a pump able to supply fluid against a pressure internal to said chamber up to said maximum pressure.

21. The device of claim 20 wherein said maximum pressure is 120,000 psi.

22. The device of claim 20 wherein said pump is a binary pump capable of generating a gradient at said maximum pressure.

23. The device of claim 20 wherein said chamber is designed and constructed to hold fluids at pressures between approximately atmosphere and said maximum pressure.

24. The device of claim 23 wherein said maximum pressure is up to approximately 5000 psi.

25. The device of claim 23 wherein said maximum pressure is up to approximately 15,000 psi.

26. The device of claim 23 wherein said maximum pressure is up to approximately 120,000 psi.

27. The device of claim 26 wherein said pressure in said chamber is between approximately 30,000 psi and 100,000 psi when fluid is impelled through said first exit opening.
28. The device of claim 1 further comprising a second exit conduit valve means interposed in said second exit conduit means.
29. The device of claim 1 further comprising a second inlet conduit valve means interposed in said second inlet conduit means.
30. The device of claim 1 further comprising a second fluid source connected to said second inlet conduit valve for supplying said second fluid.
31. The device of claim 1 further comprising at least one fitting disposed between an opening and its associated conduit means, for forming a fluid-tight seal between said opening and associated conduit means and for retaining said associated conduit means in said opening when said pressure in said chamber is elevated.
32. The device of claim 31 wherein said fitting retains said conduit means in said opening at a chamber pressure between 15,000 and 120,000 psi.
33. The device of claim 31 further comprising:
a vent opening in said housing extending from said chamber to said exterior surface for receiving a vent conduit means; and
a vent conduit means received by said vent opening in communication with said chamber for transporting fluids from said chamber out of said vent opening, said vent conduit means for connection with a vent conduit valve means.
34. The device of claim 33 further comprising a vent conduit valve means interposed in said vent conduit means having an open position wherein fluid is allowed to flow through said vent conduit valve means and a closed position wherein fluid is prevented from flowing through said vent conduit valve means, and wherein

said vent conduit valve means is responsive to a signal to assume one of said positions.

35. The device of claim 34 wherein said control means sends a supply signal to said first supply device to effect a stop state of said first supply device and sends one or more signals to said at least one valve means to effect a closed position of said first exit valve means and said second inlet conduit valve means and an open position for said second exit conduit valve means and said vent conduit valve means for discharging fluid from said chamber.

36. The device of claim 33 wherein said vent conduit means has an inner diameter between approximately 25 μ m and 150 μ m.

37. The device of claim 33 wherein said chamber has a cylindrical wall, a first end wall and a second end wall.

38. The device of claim 37 wherein said first inlet opening is positioned in one of the walls selected from said first and second end walls and said first exit opening is positioned in the other wall selected from said first and second end walls.

39. The device of claim 38 wherein said second inlet opening is positioned through said cylindrical wall proximate said first exit opening and said second exit opening is positioned through said cylindrical wall proximate said first inlet opening.

40. The device of claim 39 wherein said vent opening is positioned through said cylindrical wall approximately diametrically opposite said second input opening.

41. The device of claim 1 wherein said housing comprises an inert material.

42. The device of claim 41 wherein said inert material is stainless steel or titanium.

42. The device of claim 1 wherein said second inlet and second exit openings accommodate a conduit means having an inner diameter between approximately 15 μ m and 50 μ m.

44. A method for injecting one or more fluids into an exit conduit at high pressure comprising:

providing a housing having a chamber for receiving and/or holding one or more fluids under pressure and an exterior surface, and said housing having at least a first exit opening, a first inlet opening, a second exit opening, and a second inlet opening, each opening extending from said chamber to said exterior surface for receiving conduit means;

providing a first exit conduit means received by said first exit opening in communication with said chamber for transporting fluids from said chamber out of said first exit opening, said first exit conduit means for connection with an analytical device;

providing a first inlet conduit means received by said first inlet opening in communication said chamber for transporting a first fluid into said chamber, said first inlet conduit means for connection to a first supply device;

providing a second inlet conduit means received by said second inlet opening in communication with said chamber for transporting a second fluid into said chamber, said second inlet means for connection with a second supply device;

providing a second exit conduit means received by said second exit opening in communication with said chamber for transporting fluids from said chamber out of said second exit opening, said second exit conduit means for connection with a waste receptacle;

providing at least one valve means disposed in at least one of said first exit conduit means, said second exit conduit means and said second inlet conduit means, said valve means having a closed position wherein fluid is prevented from flowing through said valve means and an open position wherein said fluid is allowed to flow through said valve means, said valve means responsive to a signal to assume one of said open position and said closed position; and

receiving a fluid from each of said first inlet conduit means and said second inlet conduit means; and

discharging fluid through said first exit conduit means and said second exit conduit means.

45. The method of claim 44 further comprising providing a first supply device connected to said first inlet conduit means, said first supply device having a supply state wherein said first fluid is supplied at a pressure up to a maximum pressure and a stop state wherein said first fluid is not supplied, said first supply device responsive to a supply signal to assume one of said states.

46. The method of claim 45 further comprising providing a source of said second fluid in fluid communication with said second inlet conduit means.

47. The method of claim 46 further comprising providing a control means for controlling each of said at least one valve means by sending a signal to said valve means to assume one of said open and closed positions and for controlling a first supply device by sending a supply signal to said first supply device to assume one of said supply and stop states.

48. The method of claim 47 further comprising causing said control means to send one or more signals to said valve means and said first supply device to effect a sequence of positions and states for moving one or more fluids through said exit conduit means.

49. The method of claim 48 wherein said control means injects a quantity of said first fluid into said first exit conduit means by performing the actions comprising:

- a. sending a signal to all said conduit valve means to effect a closed state for sealing said chamber;
- b. sending a supply signal to said first supply device to effect a supply state for providing said first fluid and for raising a pressure of said first fluid to an impelling pressure in said chamber; and
- c. sending a signal to said first exit conduit valve means to effect an open position for injecting a quantity of said first fluid into said first exit conduit means.

50. The method of claim 48 wherein said control means injects said second fluid into said first exit conduit means by performing the actions comprising:

- a. sending a signal to said first exit conduit valve means to effect a closed position, sending a supply signal to said first supply device to effect a stop state and sending a signal to said second exit conduit valve means to effect an open position, for reducing pressure in said chamber;
- b. when pressure in said chamber reaches a ambient pressure, sending a signal to said second inlet conduit valve means to effect an open position;
- c. feeding said second fluid into said chamber until said second fluid has displaced said first fluid;
- d. sending a signal to said second inlet conduit valve means and said second exit conduit valve means to effect a closed position, and sending a supply signal to said first supply device to effect a supply state to bring said pressure in said chamber to an impelling pressure; and
- e. maintaining said pressure in said chamber at said impelling pressure and sending a signal to said first exit conduit valve means to effect an open position for a predetermined time to inject said second fluid onto said first exit conduit means.

51. The method of claim 50 wherein said device further comprises a fluid monitor that monitors a fluid passing through said second exit conduit means for providing said control means information about the composition of said fluid exiting said chamber.

52. The method of claim 51 wherein step c is replaced by:

feeding said second fluid into said chamber until said information from said fluid monitor indicates said second fluid has displaced said first fluid.

53. The method of claim 48 wherein said control means performs the actions comprising sending a signal to said first exit conduit valve means to effect a closed position and sending a signal to said second exit conduit valve means to effect an open position to reduce said pressure in said chamber and flush fluid from said chamber.

54. The method of claim 46 wherein said first fluid is a solute and said second fluid is a sample fluid.

55. The method of claim 45 wherein said first supply device is a pump.

56. The method of claim 44 wherein said first exit conduit means is a capillary.

57. The method of claim 48 wherein said device further comprises:

a vent opening in said housing extending from said chamber to said exterior surface for receiving a vent conduit means;

a vent conduit means received by said vent opening in communication with said chamber for transporting fluids from said chamber out of said vent opening; said vent conduit means for connection with a vent conduit valve means ; and

a vent conduit valve means interposed in said vent conduit means, said valve means having a closed position wherein fluid is prevented from flowing through said valve means and an open position wherein said fluid is allowed to flow through said valve means, said valve means responsive to a signal to assume one of said positions.

58. The method of claim 57 wherein said control means injects a quantity of said first fluid into said first exit conduit means by performing the actions comprising:

a. sending a signal to all said conduit valve means to effect a closed state for sealing said chamber;

b. sending a supply signal to said first supply device to effect a supply state for providing said first fluid and for raising a pressure of said first fluid to an impelling pressure in said housing; and

c. sending a signal to said first exit conduit valve means to effect an open position for injecting a quantity of said first fluid into said first exit conduit means.

59. The method of claim 57 wherein said control means injects said second fluid into said first exit conduit means by performing the actions comprising:

a. sending a signal to said first exit conduit valve means to effect a closed position, sending a supply signal to said first supply device to effect a stop state and

sending a signal to said second exit conduit valve means and said vent conduit valve means to effect an open position, for reducing pressure in said housing;

b. when pressure in said housing reaches a ambient pressure, sending a signal to said vent conduit valve means to effect a closed state and to said second inlet conduit valve means to effect an open position;

c. feeding said second fluid into said chamber until said second fluid has displaced said first fluid;

d. sending a signal to said second inlet conduit valve means and said second exit conduit valve means to effect a closed position, and sending a supply signal to said first supply device to effect a supply state to bring said pressure in said chamber to said impelling pressure; and

e. maintaining said pressure in said chamber at said impelling pressure and sending a signal to said first exit conduit valve means to effect an open position for a predetermined time to inject said second fluid onto said first exit conduit means.

60. The method of claim 57 wherein said control means performs the actions comprising sending a signal to said first exit conduit valve means to effect a closed position and sending a signal to said second exit conduit valve means and said vent conduit valve means to effect an open position to reduce said pressure in said housing and flush said second fluid from said chamber.

61. The method of claim 44 wherein said valves are freeze-thaw valves.